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(54) METHOD FOR OPERATING CNC SYNCHRONOUSLY.

(57) A method by which a plurality of CNCs (numerically controlled device), each being controlled independently, are operated synchronously. A circuit (1) for generating an external signal feeds an external timing signal to respective CNCs (2, 3) from the outside. Circuits (10, 20) for generating internal signals generate internal timing signals which operate the CNCs (2, 3) independently. Each of selecting circuits (9, 19) selects either the external timing signal or the internal timing signal. When the external timing is selected, each of the CNCs (2, 3) operates according to the external timing signal as the fundamental timing signal. Therefore, between the fundamental timing signals of the respective CNCs (2, 3), no difference of time is generated, and the respective CNCs (2, 3) can perform close synchronous operations such as an interpolation according to the fundamental timing signals.

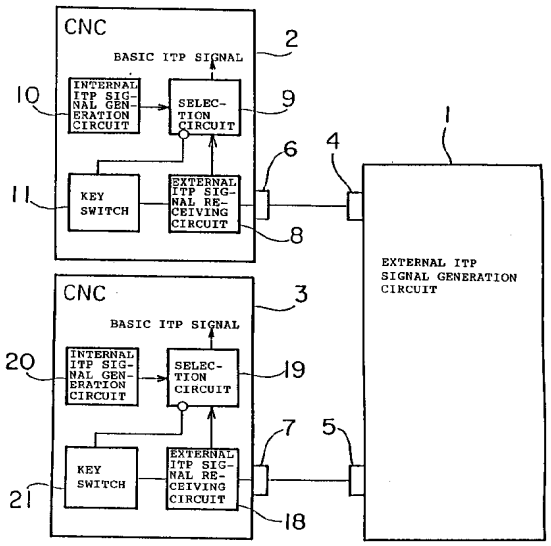

Fig. 1

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TECHNICAL FIELD

The present invention relates to a synchronized operation system for numerical control apparatuses (CNCs) used for controlling a plurality of CNCs, and more specifically, to a synchronized operation system for CNCs by which a plurality of independently controlled CNCs are made to carry out a synchronized operation.

BACKGROUND ART

Numerical control apparatuses (CNCs) are used at each station of a transfer line for machining parts for automobiles, and these CNCs contain a programmable machine controller (PMC) for controlling only a single axis. The CNCs of this type are referred to as a single-axis CNC.

Although these single-axis CNCs are usually independently controlled, sometimes a plurality of single-axis CNCs must be simultaneously controlled for cutting an arc, and to accomplish this, the I/O circuits of the respective CNCs are interconnected and data is exchanged through the I/O circuits.

Nevertheless, when data is exchanged through the I/O circuits, in operation of the respective CNCs, a time lag occurs and further, communication therebetween become complicated, and as a result, extremely closely synchronized operation, such as an interpolation, cannot be carried out.

DISCLOSURE OF THE INVENTION

Taking the above into consideration, an object of the present invention is to provide a synchronized operation system for CNCs by which extremely closely synchronized operation, such as an interpolation, can be carried out among a plurality of CNCs.

To attain the above object, according to the present invention, there is provided a synchronized operation system for CNCs by which a plurality of independently controlled numerical control apparatuses (CNCs) are made to carry out a synchronized operation, the system comprising an external signal generation means for supplying an external timing signal to each of the CNCs, from the outside, an external signal receiving means for receiving the external timing signal, an internal signal generation means for generating an internal timing signal, for operating the CNCs independently, and a basic timing signal selection means for selecting any one of the external timing signal received from the external signal receiving means and the internal timing signal received from the internal signal generation means and supplying the selected signal to the CNCs as a basic timing signal.

The external signal generation means supplies an external timing signal to the respective CNCs, from the outside, and the external signal receiving means receives the external timing signal. The internal signal generation means generates an internal timing signal for operating the CNCs independently, and the basic timing signal selection means selects any one of the external timing signal received from the external signal generation means and the internal timing signal received from the internal signal generation means, and supplies the selected signal to the CNCs as a basic timing signal.

As a result, after the basic timing selection means has selected the external timing signal, the respective CNCs are operated by using the external timing signal as a basic timing signal. Accordingly, no time lag occurs among the basic timing signals for the respective CNCs, and thus the respective CNCs can be operated while extremely closely synchronized with each other, and can cooperate to carry out even an extremely closely synchronized operation, such as an interpolation, based on the basic timing signals.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic diagram showing the arrangement of a synchronized operation system for CNCs according to the present invention; and

Figure 2 is a diagram showing another embodiment according to the present invention.

BEST MODE OF CARRYING OUT THE INVENTION

An embodiment of the present invention will be described below with reference to the drawings.

Figure 1 is a schematic diagram showing the arrangement of a synchronized operation system for CNCs according to the present invention, wherein an external ITP signal generation circuit 1 supplies an external ITP signal to a plurality (here, 2 sets) of CNCs 2 and 3. Note, the ITP (interpolation) signal is a timing signal for performing an interpolation.

The external ITP signal generation circuit 1 may be contained in a CNC different from the CNCs 2 and 3; with this arrangement, the different CNC can be operated as a master CNC and the CNCs 2 and 3 each can be operated as a slave CNC.

Further, the external ITP signal generation circuit 1 may be arranged as an independent circuit unit.

The external ITP signal is output through the connectors 4 and 5 of the ITP signal generation

circuit 1 and input to the respective CNCs through the connector 6 of the CNC 2 and the connector 7 of the CNC 3. This external ITP signal is obtained by dividing a clock contained in the external ITP signal generation circuit 1.

Since the CNCs 2 and 3 are single-axis CNCs and have the same arrangement, only the CNC 2 will be described here.

The external ITP signal supplied to the CNC 2 is received by an external ITP signal receiving circuit 8, and is supplied to a selection circuit 9 by the receiving circuit 8.

An internal ITP signal generation circuit 10 supplies an internal ITP signal to the selection circuit 9. The internal ITP signal is obtained by dividing the clock contained in the internal ITP signal generation circuit 10, in the same way as the external ITP signal.

The selection circuit 9 receiving the external ITP signal and internal ITP signal is connected to a key switch 11 which is provided for selecting any one of the external ITP signal and internal ITP signal and actuated by an operator.

When the external ITP signal is selected by the key switch 11, the selection circuit 9 selects the external ITP signal, and when the internal ITP signal is selected by the key switch 11, the selection circuit 9 selects the internal ITP signal. The signal selected by the selection circuit 9 is output therefrom as a basic ITP signal of the CNC 2.

Further, the selection circuit 19 of the CNC 3 selects any one of an external ITP signal and internal ITP signal, in the same way as the selection circuit 9 of the CNC 2, and outputs the selected signal as a basic ITP signal of the CNC 3.

When the basic ITP signals are external ITP signals, the basic ITP signals of the CNCs 2 and 3 have no time lag, and thus the CNCs 2 and 3 can be operated while being extremely closely synchronized with each other based on the basic ITP signals, and therefore, the CNCs 2 and 3 can cooperate to carry out even an extremely closely synchronized operation such as interpolation.

In this case, a communication line conventionally provided between the CNCs 2 and 3 for an extremely closely synchronized operation thereof is not necessary, and thus the communication relationship therebetween can be simplified.

When the basic ITP signals are internal ITP signals, the CNCs 2 and 3 are controlled independently, based on the respective internal ITP signals.

Figure 2 is a diagram showing another embodiment according to the present invention. This embodiment is different to the first embodiment in that a monitor circuit 12 is used in place of the key switch 11. The monitor circuit 12 is composed of, for example, a watch dog timer, and determines whether or not the state in which an external ITP signal is received has been changed, by monitoring the external ITP signal receiving circuit 8.

A selection circuit 9 selects any one of an external ITP signal and internal ITP signal, based on the result of the determination of the monitor circuit 12. More specifically, when the external ITP signal receiving circuit 8 receives the external ITP signal, the selection circuit 9 selects the external ITP signal, and when the external ITP signal receiving circuit 8 does not receive the external ITP signal, the selection circuit 9 selects the internal ITP signal.

As described above, the use of the monitor circuit 12 allows an automatic change of a basic ITP signal output from the selection circuit 9.

Although the above description refers to a case in which 2 sets of CNCs are used, the present invention can be applied in the same way to a case in which more than 2 sets of CNCs are used.

As described above, according to the present invention, since the respective CNCs are operated by using external ITP signals as basic ITP signals, no time lag occurs between the basic ITP signals of the respective CNCs, and thus the respective CNCs can be operated while being extremely closely synchronized with each other, based on the basic ITP signals, and as a result, the CNCs can cooperate to carry out even an extremely closely synchronized operation such as an interpolation.

Claims

1. A synchronized operation system for CNCs by which a plurality of independently controlled numerical control apparatuses (CNCs) are made to carry out a synchronized operation, said system comprising:

an external signal generation means for supplying an external timing signal to each of said CNCs, from the outside;

an external signal receiving means for receiving said external timing signal;

an internal signal generation means for generating an internal timing signal for operating said CNCs independently; and

a basic timing signal selection means for selecting any one of said external timing signal received from said external signal receiving means and said internal timing signal received from said internal signal generation means, and supplying a selected signal to said CNCs as a basic timing signal.

2. A synchronized operation system for CNCs according to claim 1, wherein each of said basic timing signal selection means selects any one of said external timing signal and said

internal timing signal in accordance with a selection made by using a key switch.

3. A synchronized operation system for CNCs according to claim 1, wherein each of said basic timing signal selection means selects said external timing signal when said external timing signal is received and selects said internal timing signal when said external timing signal is not received, in accordance with a result of a monitoring carried out by a monitor means for monitoring said external timing signal.

4. A synchronized operation system for CNCs according to claim 1, wherein said external signal receiving means, said internal signal generation means and said basic timing signal selection means are provided within each of said CNCs.

5. A synchronized operation system for CNCs according to claim 1, wherein said external timing signal and said internal timing signal are an interpolation (ITP) signal.

6. A synchronized operation system for CNCs according to claim 1, wherein each of said CNCs is a single-axis CNC.

7. A synchronized operation system for CNCs according to claim 1, wherein said external signal generation means is contained in a CNC other than said plurality of CNCs.

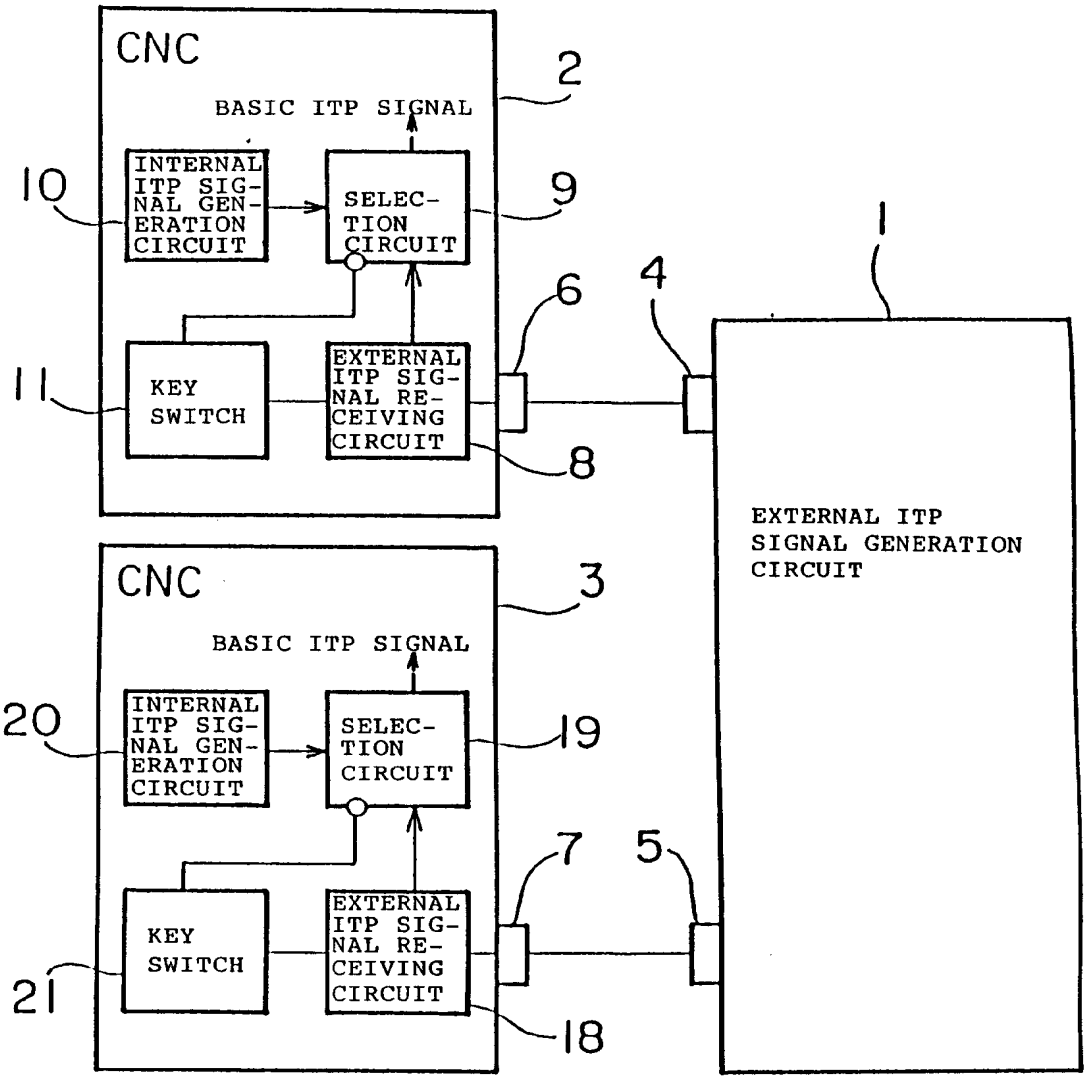
CNC
2
BASIC ITP SIGNAL
10
INTERNAL ITP SIGNAL GENERATION CIRCUIT
SELECTION CIRCUIT
9
11
KEY SWITCH
EXTERNAL ITP SIGNAL RECEIVING CIRCUIT
6
8
4
1
EXTERNAL ITP SIGNAL GENERATION CIRCUIT
CNC
3
BASIC ITP SIGNAL
20
INTERNAL ITP SIGNAL GENERATION CIRCUIT
SELECTION CIRCUIT
19
21
KEY SWITCH
EXTERNAL ITP SIGNAL RECEIVING CIRCUIT
7
5
18

Fig. 1

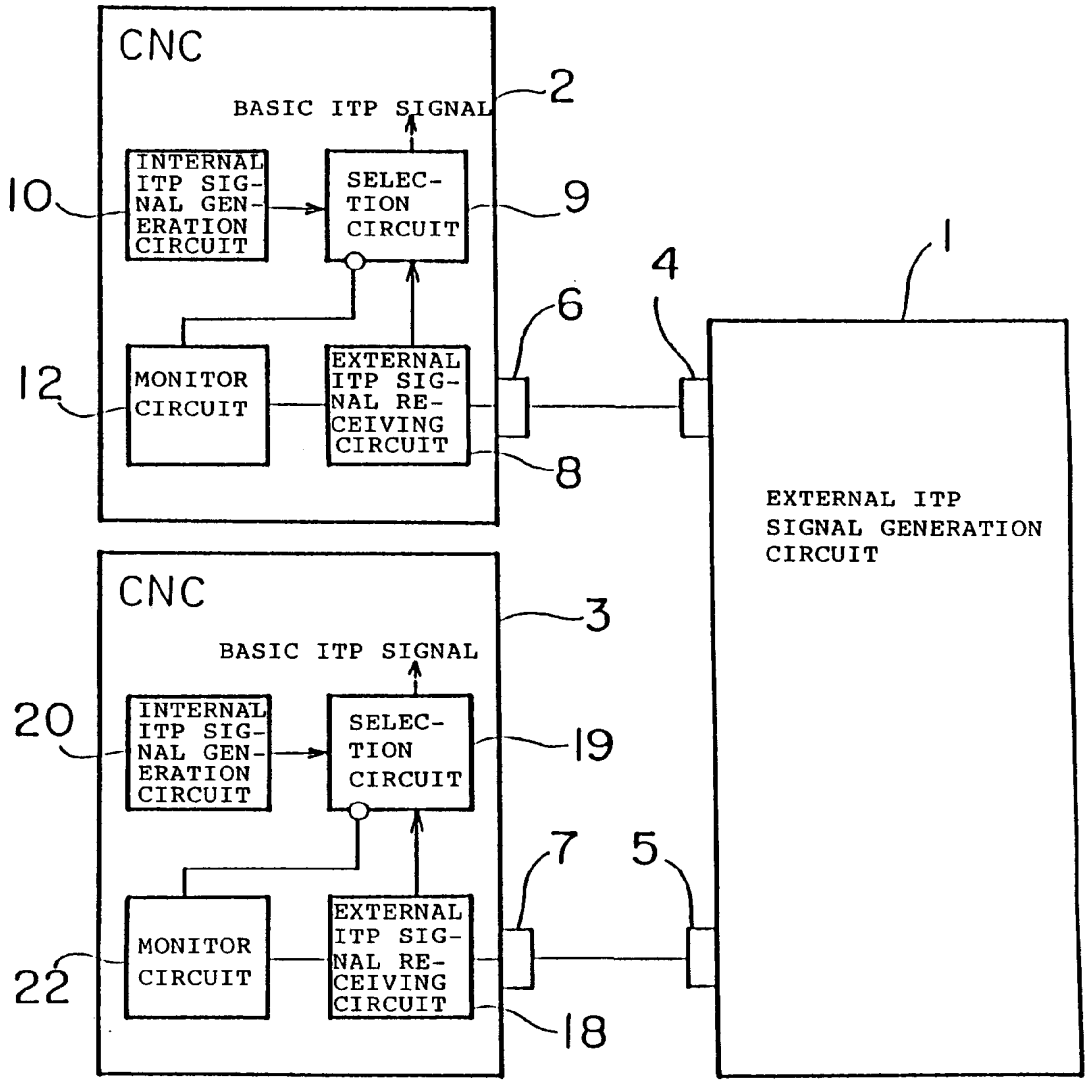
CNC
BASIC ITP SIGNAL
2
INTERNAL ITP SIGNAL GENERATION CIRCUIT
10
SELECTION CIRCUIT
9
MONITOR CIRCUIT
12
EXTERNAL ITP SIGNAL RECEIVING CIRCUIT
6
8
4
1
EXTERNAL ITP SIGNAL GENERATION CIRCUIT
CNC
3
BASIC ITP SIGNAL
INTERNAL ITP SIGNAL GENERATION CIRCUIT
20
SELECTION CIRCUIT
19
MONITOR CIRCUIT
22
EXTERNAL ITP SIGNAL RECEIVING CIRCUIT
7
5
18

Fig. 2

INTERNATIONAL SEARCH REPORT

International Application No PCT/JP91/01370

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl[5] G05B19/18

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	G05B19/18

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

Jitsuyo Shinan Koho 1932 - 1991
Kokai Jitsuyo Shinan Koho 1971 - 1991

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	JP, A, 60-3007 (Kogyo Gijutsuin-cho), January 9, 1985 (09. 01. 85), (Family: none)	1-7
Y	JP, A, 60-45808 (Nippon Sheet Glass Co., Ltd.), March 12, 1985 (12. 03. 85), (Family: none)	1-7
Y	JP, A, 63-298604 (NEC Corp.), December 6, 1988 (06. 12. 88), (Family: none)	1-7
Y	JP, A, 63-54606 (Mitsubishi Electric Corp.), March 9, 1988 (09. 03. 88), & US, A, 4862379	1-7

* Special categories of cited documents: [10]

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
December 16, 1991 (16. 12. 91)	January 14, 1992 (14. 01. 92)
International Searching Authority	**Signature of Authorized Officer**
Japanese Patent Office	